AN ACCOUNT OF EXPLOSIONS IN THE ATMOSPHERE, OR AIRQUAKES.

Their DISTINCTION from TRUE EARTHQUAKES.

WITH

Some Obſervations on the late Shocks, near this City, &c. to ſhew that they were moſt probably of the former Kind.

> ——— *Et rubente*
> *Dexterâ Sacras jaculatus arces.*
> *Terruit Urbem.*
>
> Hor. L. i. Od. ii.

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AN ACCOUNT OF EXPLOSIONS IN THE ATMOSPHERE, OR AIRQUAKES, &c.

AS the Terror of the late Shocks and the Apprehenſions of another are at length abated, an impartial Diſquiſition into the Nature and Cauſe of them will not perhaps be diſagreeable to the Public.

BIBL CANT ACAD

Whilſt an univerſal Panick had ſeized Mankind, whilſt they imagined every Moment to be their laſt; and that Heaven itſelf threatned us with Deſtruction; it was in vain to have recourſe to Reaſon, or offer any Hypotheſis not adapted to our Horrour.

I would not be underſtood from theſe reflections univerſally to condemn the Conſternation of the Metropolis, much leſs to cenſure our Reliance on Providence in this and all other Occaſions. The dreadful Conſequences of Earth-quakes in general, and the Conſideration of the fatal Ruin that has attended ſome in different Parts of the World within the laſt Century; together with the full Perſwaſion that the late Phœnomena were really ſubterranous, might in ſome Meaſure juſtly alarm the boldeſt.

My Deſign in the following Diſquiſition is to examine whether our Apprehenſions were rightly founded, and whether Philoſophers have not been miſtaken in their Reſolutions concerning them.

There are only two Methods by which we may pretend to account for ſuch Appearances, either as real proper Earth-quakes; or as Exploſions in the Atmoſphere. How far Religion is concerned will be afterwards conſidered; for whether we apprehend them to reſult from the immediate Direction, or from the general eſtabliſhed Laws of Providence, they are certainly produced by the Interpoſition of natural Cauſes.

Several Treatiſes have been recommended to the World in ſupport of the prevailing Opinion of

Earth-quakes, but upon a candid peruſal of them I wonder not at the little Satisfaction they have afforded the Publick, the Authors are pleaſed to content themſelves with common Place Deſcriptions of the Cauſe and dreadful Effects of ſubterraneous Exploſions, their various Species, and the Number that has happened in this Iſland, and different Places of the Globe, and hence from many uſual Reſemblances between Earth-quakes and ſome Aerial Concuſſions, they have included them all under the like Denomination.

The celebrated Mr. *Flamſteed* was extremely ſenſible of the Error in blending theſe Phenomena, and has in a * Letter upon this Subject preſented us with ſeveral Obſervations which greatly tend to illuſtrate the Diſtinction.

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* A Letter concerning Earth-quakes, written on Occaſion of the Deſtruction of *Catanea* in *Sicily*, 1692.

The ſentiments of ſo eminent a Philoſopher collated with other Circumſtances, invited me to conſider the Hypotheſis with more Exactneſs, and to ſubmit my Reaſons to the unprejudiced Reader, why it may be preſumed, that not a few of thoſe Concuſſions eſteemed ſubterraneous, may with greater Propriety be referred to the Atmoſphere, and be Characteriſed by the Name of Air-quakes, particularly the remarkable ſhocks which lately happened near this Capital, and in other Parts of *England*. In Order to remove ſome of thoſe Intricacies which unavoidably attend Enquiries of this kind, the following Proceſs will perhaps be moſt proper and effectual.

Fiery Exploſions of all Sorts; whether in the Earth or Atmoſphere are looked upon by Philoſophers to proceed from the Mixture of Nitre, Sulphur, and other Vapours, when a due Proportion of theſe Ingredients meet together, they ferment, or by ſome other means take Fire, explode, and are oftentimes accompanied with very dreadful Effects.

That both the Earth and Atmoſphere abound with Exhalations of all kinds no one pretends to Diſpute, the Earth indeed is the common Parent of them all; but a ſufficient Store is thence emitted into the Air to occaſion Shocks, if not ſo dangerous in their Conſequences as Earth-quakes, yet in ſome reſpects ſimilar and equally ſurprizing.

When theſe Combuſtibles are enkindled underground, and explode to ſuch a Degree as to be followed with a *Terræ Motus*, or Motion of the Earth, then are they entitled Earthquakes. Theſe are * diſtinguiſhed into various kinds according to their different Effects. But they are more Philoſophically deſcribed by the Manner of their Motion. If the Earth moves from the Center or perpendicularly then it is called a Pulſe; if laterally, horizontally, or undulating like Waves; then a Vibratory Earthquake, theſe Phænomena are frequently attended with Eruptions, the overturning of Mountains, ſwelling of the Sea, removing large Tracts of Land, the Deſtruction of Cities, and other direful Reſults, of which the more modern Shocks at *Quebec*, *Port-Royal*, and *Lima*, are fatal Examples.

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* Diſſertation on Earthquakes.

If theſe inflammable Compoſitions take Fire in the Air, they alſo in Conſequence of their different Effects receive various Denominations, when they moſtly conſiſt of ſulphureous Vapours, appear in ſmall Quantities, and are not accompanied with Exploſions, they preſent us with the *Ignes Fatui*, falling Stars, and others Salient Meteors, when theſe Evaporations are more plentiful and abundant, they form the *Aurora Borealis* or Northern Lights; if again the ſulphurous Exhalations are intermix'd with ſuch Ingredients as will produce Exploſions, then they conſtitute Thunder and Lightning, and ſometimes thoſe Shocks, which by Way of Eminency are called Exploſions in the Atmoſphere, and which from ſome Reſemblances they bear to ſubterraneous Convulſions, we may not improperly diſtinguiſh by the Title of Airquakes.

Moſt of theſe Appearances with their Effect are in ſome Meaſure capable of being repreſented by Experiments. * Dr. *Hales* has by a very ingenious Contrivance ſhewn the Formation of the Northern Lights from the Conſequences that the Mixture of a pure and a ſulphureous Air have on each other. Artificial Earthquakes, and Exploſions in the Atmoſphere can be ſo exhibited in Miniature as to afford not a little Similitude of them which happen in Nature.

A Compoſition of twenty Pounds of Iron filings and as many of Sulphur, tempered with a little Water to the Conſiſtence of a Paſte and depoſited four Foot under Ground, will in a few Hours, occaſion a Trembling in the Earth and emit Fire.

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* See his Appendix to his *Statical Eſſays* and his *Conſiderations on the Cauſes of Earthquakes*, page 10.

The *Aurum Fulminans*, which is a Mixture of Salt of Tartar and Gold diſſolved by *Aqua Regia*, likewiſe the *Pulvis Fulminans*, which is a Mixture of three Parts of *Nitre*, two of Salt of Tartar, and one of Sulphur; if heated with the Flame of a Candle or warmed by Fire to a certain Degree, Explode with great Violence. But a more perfect Reſemblance of Aerial Concuſſions may be imitated from a due Mixture, of Spirit of *Nitre*, Oyl of *Vitriol* and an equal Quantity of Oyl of *Turpentine* poured upon it, ſuppoſe an Ounce of each: from this Compoſition there will ſuddenly ariſe a very fine Flame with a great Exploſion.

Having for the Clearer illuſtration of the Sequel given the generally received Philoſophy of inflammable Vapours and fiery Exploſions, we ſhall the more readily apprehend how an Airquake is formed, and how it differs from ſubterraneous or other remarkable Effects.

When any Part of the Atmoſphere is replete with Conbuſtibles, it only requires a due Concurrence of Circumſtances to raiſe a Fermentation and enkindle them. When this Diſpoſition happens, the Ingredients take Fire, explode and ſometimes conſtitute an Airquake or violent Concuſſion of the Atmoſphere, ſtrong enough to overturn Buildings and produce other Effects.

This Phænomenon varies from Thunder and Lightning, as a greater Cauſe from a leſs. Succeſſive Flaſhes and repeated Sounds attend them, like the firing of Guns one after another. An Airquake reſembles the Diſcharge of ſeveral Canon at once or very near together. The former are commonly more partial, and the Percuſſions not ſo violent, the latter is a more general Exploſion of a Collection of Combuſtibles in any determinate Space of the Atmoſphere.

Airquakes are uſually accompanied with Balls or Globes of Fire, Lightning and other Appearances, which indeed are only the inflammable Subſtance itſelf enkindled and formed into this Repreſentation: they are alſo frequently followed by Storms of Rain or Hail.

Natural Hiſtory will ſupply us with abundant Teſtimonies of theſe Exploſions diſtinct from real Earthquakes. I ſhall only mention two, not leſs remarkable than Modern, and which indeed have been already recommended to the Conſideration of the Public.

The firſt happened at *London*, *Suſſex*, *Kent*, *&c.* on *December* 11th, 1741, the following Account of which a † Gentleman tranſmitted to the *Royal Society*.

‘ About one in the Afternoon I
‘ found my Houſe violently ſhaken
‘ for ſome Seconds of Time, as if
‘ ſeveral loaded Carriages had been
‘ driving againſt my Wall, and heard
‘ a Noiſe, which at firſt my Family
‘ took for Thunder, but of an un-
‘ common ſound: for my own Part,
‘ (as I thought Thunder which
‘ would ſhake us at that Rate,
‘ would have been much louder) I
‘ concluded it an Earthquake, and
‘ going immediately to the Top of
‘ my

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† *Philoſoph. Tranſactions Martin's* Abridgment, V. 8

‘ my Houſe, found the Sky cloudy,
‘ but nothing like a Thunder Cloud
‘ in View, only there was a Shower of
‘ Rain from the Eaſtward preſently
‘ after, and the Coldeſt that I have
‘ felt. I thought it the Shock of
‘ an Earthquake, as I told you be-
‘ fore, but ſince find it was attended,
‘ (and I ſuppoſe cauſed) by a Ball of
‘ Fire which paſſed with great ra-
‘ pidity over our Country from
‘ Weſtward to Eaſtward; for how
‘ long a Journey I cannot tell. It
‘ began with two great Blows, like
‘ the Reports of Cannon (which the
‘ Jumbling of my Saſhes prevented
‘ my diſtinguiſhing) and then rolled
‘ away till it was heard no more.
‘ The Appearance I hear was as that
‘ of a very large ſhooting Star.
‘ And it left a Train of Light,
‘ which ſoon diſappeared, it being
‘ Noon-day. I met a Pilot to Day
‘ coming from *Deal*, whom I ask-
‘ ed

‘ ed about it, and he told me he
‘ ſaw no Fire-ball, but heard the
‘ Noiſe, and that it made the Ship
‘ he was in ſhake.

The Violence of the Shock occaſioned by this Meteor was at leaſt equal to the late Exploſions as appears from the Relation concerning it drawn up by a Gentleman in *Suſſex*.

‘ In the Afternoon between
‘ twelve and one, all this Part of the
‘ Country was alarmed with a moſt
‘ terrible Clap of Thunder, as it is
‘ generally imagined. The ſound
‘ came from the North, where the
‘ Weather appeared very Black in
‘ the Morning. Our Neighbours
‘ thought ſome Powder-mill had
‘ been blown up. I have it by Re-
‘ port, that a Countryman ſaw a
‘ Flaſh of Lightning before he heard
the

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‘ the Noiſe. If it was Thunder and
‘ Lightning the Effects of it muſt
‘ be very terrible ſomewhere, for it
‘ gave the ſame Report, and ſhook
‘ all the Houſes, juſt in the ſame
‘ Manner, that were above twenty
‘ Miles diſtant from one another,
‘ North and South, which I think
‘ is an Argument that it was more
‘ * general than Thunder can poſſibly be.

A ſecond but more limitted Appearance of the ſame Kind was obſerved in the *Iſle* of *Wight* laſt Summer. A ſhort Deſcription of it was publiſhed in the *General Advertiſer*, *Saturday April* 14th.

‘ We had a ſtrange Pænomenon
‘ here on *Wedneſday* in *Whitſon*
‘ Week, a large Globe of Fire fell
in-

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* Farther Accounts of this Pænomenon may be ſeen in *Martin*'s Abridgement of his *Philoſ. Tranſ.* V. 8 Pag. 2.

‘ into the Sea near the *Needles*, be-
‘ tweent welve and one at Noon: a
‘ thick Cloud of black Smoak
‘ aroſe from that Part of the Sea
‘ where it fell; I * both heard and
‘ felt it, it ſhook my Houſe to a
‘ great Degree”.

The Atmoſphere where theſe Appearances occurred was at the Time plentifully ſtored with ſulphurous and exploſive Vapours, which collecting together and taking Fire were the Cauſe of the Repreſentations and Shocks above recited.

How ſimple a Body ſoever our Air ſeems to be (ſays || Mr. *Flamſteed*) yet I doubt not that upon ſerious Reflection, you have concluded it to be a vaſt Compound of aqueous,

oily,

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* See *General Advertiſer*, *April* 14th, 1750. An Extract of a Letter from the *Iſle* of *Wight*, dated *June* 3d. 1749.

|| *Flamſteed*'s Letter on Earthquakes pag. 11.

oily, ſaline, nitrous, ſulphureous and other Particles of which ſome may poſſeſs the greater Part in a certain Space at one Time, others at another.

As to the Reality therefore of Airquakes, I ſhould imagine, no one can pretend to controvert it, ſince they have frequently happened in the Proceſs of Nature, and have ſometimes Marks ſufficient to diſtinguiſh them from other Phænomena.

The Misfortune is, Mankind for want of accurate Enquiries and juſt Obſervations are liable to confound Things that have any diſtant Similitude to each other, and this perhaps is no where more common than in Points of Philoſophy, and particularly in the Caſe before us.

Earthquakes and Exploſions in the Air often produce many ſimilar, tho'

tho' not equal Effects, they are both frequently preceded by Illuminations in the Sky; the Air is ſtill, and calm, they are accompanied with unuſual Sound and ſometimes terminate in Shocks that threaten the downfal of Houſes; hence, whenever any of theſe Events occur, the World immediately without Diſtinction calls it a ſubterraneous Exploſion.

True Earthquakes, it has been obſerved, are produced by the taking Fire of Sulphur and other Ingredients, under Ground, and are generally attended either with Eruptions or Eructations near the Spot where the Exploſion moſt forcibly vents itſelf, ſuch was the Conſequence of the Shocks at *Lima*, *Jamaica*, *&c.* And uncommon Eructations are the Reſults of *Mount Ætna*, when Earthquakes alarm the Neighbourhood.

The Coaſts along the *Mediterrean*, and various other Countries on the Globe, as *Peru*, *&c.* are known to be abundantly repleniſhed with Materials that occaſion ſubterraneous Exploſions, and therefore the frequency of them in thoſe Parts, and the dreadful Effects which enſue are indeed horrid, but not unexpected; other Places of the Earth are more thinly furniſhed with Ingredients productive of theſe Convulſions, and yet are ſupplied with a ſufficient Quantity to replete the Atmoſphere with Exhalations, and conſquently appear or explode as different Circumſtances offer, ſuch is the Diſpoſition of our fortunate Iſland, it does not abound with the *Pyrites*, *Iron-ſtone*, or that Mineral Subſtance which affords the greateſt plenty of ſulphureous Vapours, the Inquiſitive have found it very thinly ſcattered in moſt Parts of *England* in comparifon pariſon of other Countries and hence it has happened, that not Thirty reputed Earthquakes have been obſerved in this Nation for more than Seven Centuries paſt, and moſt of theſe upon Examination may be reduced with greater Propriety under the Deſcription of Aerial Concuſſions.

[*] Mr. *Flamſteed* acquaints us, that 'tis not probable, that either the ſmall *Cheſhire* Earthquake, or that which happened at *Oxford Jan.* 19 1665-6, were cauſed by Vapours emitted from any ſubterraneous Caverns or Eruptions; for we hear not of any Eruptions that happened in or near thoſe Places at that Time. And therefore he rather eſteems them to have been Exploſions in the Air.

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[*] In his Letter concerning Earthquakes p. 17

The ſame Author is pleaſed farther to elucidate the Diſtinction from the ſubſequent Obſervations.

1ſt. ‘ I cannot conceive (ſays he) ‘ why Noiſes ſhould always be heard ‘ in the Air when Earthquakes ‘ happen, nor why they ſhould not ‘ be heard every where under the ‘ Earth as well as in thoſe Places in ‘ or near which Eruptions are ‘ made”.

2d. ‘ ’Tis more hard to imagine ‘ how the Earth ſhould he ſhook ‘ under the Waters and the Ships ‘ riding on them, tremble or receive ‘ a Shock, as if they had ſtruck up‘on a Rock, and yet the Waters ‘ themſelves between them remain ‘ unmoved”.

3d. ‘ I cannot apprehend (if all ‘ Earthquakes muſt be made by

Ex-

‘ ploſions in ſubterraneous Caverns)
‘ why ſometimes a large Country
‘ or whole Continent ſhould be
‘ thereby ſhook all at once, and,

4th. ‘ At other Times, only a
‘ ſmall Part in the Middle or ſome
‘ Corner of it; and that ſucceſſive-
‘ ly and ſlowly; nor why there
‘ ſhould not be Eruptions as well
‘ when ſmall as great Earthquakes
‘ happen.

‘ 'Tis abſurd to affirm that any
‘ Exploſion of a conſiderable Depth
‘ under the Earth ſhall ſhake the
‘ upper Stories of Houſes ſenſibly
‘ more than the lower, conſidering
‘ what a ſmall Proportion the Height
‘ of an Houſe bears to the Thick-
‘ neſs of the Shell of the Earth (if
‘ we muſt allow one) that it is ſup-
‘ poſe to ſtand on.

‘ ’Tis improbable then, that
‘ Earthquakes of any large Extent
‘ ſhould be cauſed by ſubterraneous
‘ Exploſions, or even ſmall ones,
‘ where there are no Eruptions in
‘ the Neighbourhood, all the fore-
‘ recited Circumſtances ſeem to Point
‘ out our liquid and fleeting Air to
‘ be the Place in which their ab-
‘ ſtruſe, effective Cauſe reſides, and
‘ there we ſhall find it, or at leaſt
‘ the greateſt Part of it”.

He has upon this Suppoſition philoſophically reſolved the undulating * Motion that attends them, and proved how the Houſes on Land ſhall be ſhook thereby, as we find by Experience they are, and Ships at Sea without any ſenſible Motion of the Waters.

This Gentleman, we may obſerve, had

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* See *Flamſteed's* Letter pag. 15.

had formed a clear Diſtinſtion between theſe Phænomena, and acquaints us that many of the Shocks generally looked upon as ſubterraneous, may with more Reaſon and Exactneſs be accounted for by refering them to the Atmoſphere; * and from this Hypotheſis even attempted to ſolve the deſtructive *Sicilian* Concuſſions in the Year, 1692.

The moſt certain infallible Notes to aſſure us of ſubterraneous Shocks, are Eruptions, or real central Motions of the Earth. When theſe Circumſtances offer, we may undeniably trace the Cauſe under Ground.

But if there are no Eruptions ſubſequent to the Exploſion; if the Noiſe is diſtinctly in the Atmoſphere, and proceeds not with a Hollow

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* His Letter concerning Earthquakes, *&c.*

murmuring Sound from beneath; if the Concuſſions are ſenſibly lateral or vibratory; if the Motions chiefly affect the higher Parts of Houſes, &c. and gradually decreaſe downward; if the Superficies of the Earth and Buildings are moſtly acted upon; if farther, the Diſpoſition of the Country and ſcarcity of Combuſtibles exempt it from the Danger of ſubterraneous Shocks, but are ſufficient to anſwer Exploſions in the Air; if laſtly the Phænomenon is accompanied with a Fire-Ball, Storms of Rains or Hail, &c. we have the ſtrongeſt Reaſon imaginable to preſume it in the Atmoſphere; but all theſe Effects taken together, we have no Arguments to prove, and little Colour of Probability to ſuppoſe it ſubterraneous.

Having thus far endeavoured to illuſtrate and eſtabliſh the Difference between true Earthquakes and Exploſions in the Atmoſphere, it may be proper to apologize for the Appellation of Airquakes. The Word Exploſion is too general a Term, as it includes not only ſuch particular Shocks, but likewiſe Thunder and Lightning, and may be extended to the Diſcharge of Artillery, blowing up of Powder Mills, or other Magazines of Combuſtibles. All theſe Exploſions indeed create a Trembling or Vibration in the Atmoſphere proportionable to the Matter collected, but as the Spring or Elaſticity of the Air is more forcibly acted upon in the Shocks above repreſented, and as it will alſo more expreſſively denote their Variation from underground Convulſions, it may not be amiſs to appropriate to them the Name of Airquakes.

If now we compare the late Shocks

in ſeveral Parts of *England*, and particularly thoſe near the Metropolis, with the Deſcription of Airquakes, we ſhall find all all their Circumſtances eaſily to be reſolved upon this Hypotheſis; but that they wanted the Eſſentials of ſubterraneous Exploſions, and have nothing to prove them ſo, but ſome Reſemblances common to both; as a Calmneſs of the Air, unuſual Warmth, ſulphureous Smell, Vibratory Motion, *&c.*

The firſt Shock happened in and about *London*, on *Thurſday*, *February* the 8th, 1749---50, at Thirty Minutes after Twelve. The Appearances and Effects accompanying it were the fo lowing.

1ſt. The Weather had been rainy and cloſe for ſome Days; there had been a thick Fog in the Morning, and at the Time of the Shock, the

Air was remarkably hazy, warm and calm.

2d. The Sound or Noiſe was flat, and ſeemed to Perſons in lower Apartments of their Houſe, as if ſomething had fallen in the Rooms overhead.

3d. * The Motion was vibrating, and acted with a Force ſufficient to ſhake Buildings, *&c.* and was the more ſenſible to Perſons as their Situation was higher from the Surface of the Earth. The Noiſe and Shock were alſo at the ſame Time.

The Second was on *March* the 8th, 1749—50, about Twenty Minutes before Six in the Morning, and continued about three or four

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* See Account of it in *Diſſertation on Earthquakes*, pag. 65.

Seconds of Time, and in ſome reſpects varied from the former.

1ſt. The Sound was louder but alſo flat.

2d. The Shock was more violent ſo as to ſhake the Beds, Windows, Houſes, *&c.* more ſenſibly; but the Motion was likewiſe lateral or vibratory.

3d. * The Soldiers, who were on Duty in St. *James*'s *Park* and others who were up, ſaw a blackiſh Cloud with conſiderable Lightning or a Ball of Fire juſt before the Exploſion. And it was reported that a Storm of Hail fell Eaſtwards ſoon after.

Since theſe Exploſions there have

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* See Dr. *Hales*'s Account of it in his *Conſiderations on Earthquakes.*——— *The Theory and Hiſtory of Earthquakes.* pag. 21, *&c.*

been others in different Parts of *England*, as at *Bridport*, *Portſmouth*, and *Cheſter*, *&c.* The moſt genuine Accounts tranſmitted concerning them, ſhew, that they were all owing to ſimilar Cauſes. It will therefore be ſufficient to conſider the Shocks near this Capital, as the ſame Solution may be juſtly applied to the reſt.

We may remark of them in General, that their Force was confined within a limited Space of the Atmoſphere, neither of thoſe at *London* extending more than Twenty Miles or thereabouts; whatever Effects then attended them, muſt fall within that Compaſs. The Exploſions, and indeed greateſt Violence of the Shocks in general ſeem by moſt Accounts to have been at no conſiderable Diſtance from the City weſtward; hence it was reported, and naturally ſuſpected by the Advocates for

Earthquakes that Eruptions might be found in the Neighbourhood; but the Suſpicion proved groundleſs, and the Report falſe.

As they were not accompanied with any Eruptions, ſo neither was the Motion Central or Perpendicular; but undulating or vibratory, and the Reciprocations were repeated with great Quickneſs, 'till the Concuſſions ſubſided. Hence * the laſt Exploſion was ſuppoſed to be an Earthquake, moving from Eaſtward to Weſtward, which indeed was agreeable to its lateral and undulating Direction.

|| To this it is objected, that a Servant felt a Marble Slab move under her Hand, as ſhe was cleaning it, and Dr.

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* See Dr. *Hales*'s Conſideration on Earthquakes. pag. 20.

|| See the ſeveral Accounts of the Shocks, in *Diſſertation on Earthquakes.*—— *Theory of them.*—— And Dr. *Hales*'s Conſideration on them.

Dr. *Hales* obſerves, that he very ſenſibly felt his Bed heave, and conſequently that the Earth muſt heave too; but with Submiſſion I cannot look upon the Conſequences as any Ways concluſive.

If we recollect the incumbent Weight of the Atmoſphere, which is determined by the Torricellian Experiment to be about fifteen Pounds upon every ſquare Inch near the Surface of the Earth; if farther we conſider its ſurprizing diſtinguiſhed Property of Elaſticity, by which it contracts itſelf into a leſs Space, when an additional Preſſure is laid upon it, and recovers its former Dimenſions when the Preſſure is taken off, if laſtly we obſerve how the incumbent Weight and Force of the Atmoſphere may be encreaſed by Rare-faction and Condenſation or other Circumſtances, we ſhall readily apprehend how all the above Effects may be produced, without the Aſſiſtance of a ſubterraneous Shock. The additional Preſſure, Condenſation's, &c. occaſioned in particular Parts of the Air by Exploſion's, &c. with its Endeavour to recover its former Space by its elaſtic Force, is not only ſufficient to give a Motion to Slabs, Pavements, Beds, and other Things, only relatively and perhaps looſely fixed to the Ground; but moreover to affect the Superficies of the Earth itſelf with a Tremor ſo far as it falls within its Center of Activity, and alſo to produce other extraordinary Events.

We may hence more, rationally infer, that, as the Shock was ſo violent, if it had been a real Earthquake, a conſiderable Eruption would have enſued; a central Motion would have been ſenſibly and generally felt, the

Foundations of the Houſes would have been ſhaken, and the Miſchief kept Pace with the Horrors of the Town.

As to the vaſt Extent and Force of Exploſions in the Air, we may form ſome Apprehenſions of them from ſeveral Obſervations. Mr. *Flamſteed* acquaints us, that when the great Guns were diſcharged at the Tower, or on the River, tho' four Miles from his Houſe, the Exploſion ſhook his Windows. When the Bridge of *Antwerp* was blown up (at the ſame Time the Prince of *Parma*, beſieged the Town) by a Mine of Gunpowder and Compoſition placed in a large ſtrong Lighter, the * Hiſtorian ſays the Blow was felt many Miles off; and Thunder Claps frequently produce the like Effects. If therefore we ſuppoſe a

larger

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* See *Flamſteed*'s Letter, &c.

larger Collection of Combuſtibles to explode in any particular Space of the Atmoſphere, we cannot but expect a proportionable Shock in the adjacent Places.

It may be objected that the firſt Exploſion was preceded by rainy Weather, that no Lightning was obſerved at the Time, nor any Storm enſued, and hence it may be concluded, that it was a real Earthquake. It will, I ſuppoſe, be granted, that the Rains precipitated a great Quantity of the ſulphureous Vapours, but likewiſe, that it might leave a ſufficient Store to produce a Shock; probably the Waters were before too plentiful in the Air, and ſo prevented the Accenſion or enkindling of the inflammable Subſtance, &c. How much ſoever Thunder-Storms cool the Element, and diminiſh the ſulphureous Steams, yet enough remain for frequent Repetitions. It does not follow, there was no Lightning, becauſe it was not obſerved; the Exhalations may catch at once, like Gunpowder ſpread on a Street, and the Light may be too ſubtile for our Eyes, particularly in the * Day-time. As to Storms, they are no more neceſſarily required after Aerial than ſubterraneous Exploſions.

The ſecond Shock was preceded by dry Weather, was accompanied with a black Cloud; a Lightning, or Globe of Fire appeared at the Time of the Exploſion, and a Hail-ſtorm is reported to have followed ſoon after Eaſtward.

This Pænomenon partly reſembled that which happened in the Year, Forty One. It was indeed more limited, and conſequently the Effects more partial. We may with no little Pro-

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* See Mr. *Flamſteed*'s *Letter*.

Probability ſuppoſe that the Warm and dry Weather which intervened between the two Shocks might again exhale the Effluvia precipitated by the Rain, &c. and theſe Evaporations meeting with others in the Atmoſphere were ſufficient to anſwer the Violence of the ſecond Concuſſion; either it aroſe from a Collection of Vapours in the Air, or the Exploſion of Combuſtibles under Ground in the Neighbourhood. On the latter Hypotheſis certainly an Eruption muſt have been found, unleſs it can be ſhewn that there are ſufficient Cavities occaſioned by former Earthquakes to give Vent to the Matter, as in *Sicily*, and other Countries ſubject to repeated Shocks.

An * Author has endeavoured to account for the firſt Exploſion, by ‘ ſuppoſing that the Rain which

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* See *Diſſertation on Earthquakes*,

‘ then fell, (the Winter having been
‘ remarkably dry ’till within a few
‘ Days before) might penetrate very
‘ deep into the Earth; and if in any
‘ of the Commons, Heaths, or barren
‘ Grounds, not far diſtant from
‘ this Capital, there be, as reported,
‘ Coals in the Earth, theſe, if, of a
‘ ſulphureous Kind, might through
‘ their becoming wet in this Manner,
‘ emit a Vapour capable of producing
‘ ſuch a Shock as was felt”.

This Gentleman’s Solution, beſides the *Petitio Principii*, or begging of the Queſtion, is in other Reſpects deficient. We might on this Suppoſition, not only have expected an Eruption, but a more general Shock, particularly in thoſe Parts remarkable for Coal-Mines. And as we may undoubtedly refer both to the ſame Cauſe, the continued dry Weather preceding the laſt Concuſſion,

ſion, inevitably ſhews that it could not be owing to ſuch a Diſtillation.

Another leſs judicious ‖ Author, a warmer Advocate for Earthquakes, than Reaſon, is pleaſed to aſſert.

‘ That the Exploſion of a Ball ‘ of Fire capable of ſhaking the ‘ Earth, and conſequently the Houſes ‘ for ſo wide an Extent, muſt de‘ſtroy every Thing within the Sphere ‘ of its more immediate Activity. If ‘ a Ball of Fire had burſt over *Weſt‘minſter* with ſuch a Violence, as ‘ by a Percuſſion of Air to move ‘ the Bells at *Beckingham* and *Croy‘don*, the Houſes of *Weſtminſter* ‘ would have been ſtruck down ‘ with the Blaſt, and the Men deaf‘ned by the Violence of the Report. ‘ The City of *London* would have ‘ been ſtunned with the Sound, and ‘ ſhattered by the Blow. This indeed

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‖ Author of the *Theory* on *Earthquakes*.

'deed contains a vaſt Exploſion of
'Words, but little Conſideration of
'the Phænomenon ‖.

If the Gentleman will cooly recollect the Fire-balls before deſcribed, he may obſerve, that neither of them produced within its immediate Sphere of Activity, ſuch dreadful, tremendous Conſequences, as his Terrors ſuggeſted. The firſt in Forty One acted with a Violence and Extent, at leaſt equal to the late Exploſion, and nevertheleſs it was not attended with any remarkable Demolition of Buildings, or other tragical Events: So far is his Objection from being concluſive, that the contrary might be true; of which Mr. *Flamſteed* affords us an eminent Example.

'* When the Powder-mills (ſays
'he) blew up, ſome years ago, on
'*Bamſtead Downs*; an Houſe but

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‖ See *Theory and Hiſtory of Earthquakes.*

* *Flamſteed*'s Letter on Earthquakes, pag. 11.

‘ an hundred Yards to the Wind-
‘ ward, received no Damage, but
‘ another Six Miles diſtant to
‘ the Leeward, had all the Windows
‘ broke and ſhattered”.

According to this Gentleman's Philoſophy and Style; the firſt Houſe ought to have been cruſhed to Atoms, crumbled into Duſt, and ſcattered through the Atmoſphere.

The Manner and Proceſs of Aerial or ſubterraneous Shocks cannot with any Exactneſs be determined; various Circumſtances may occur to alter the Direction and augment, or diminiſh their Force in different Places. Perhaps the ſudden breaking of the Elaſticity of the adjacent Air deſtroyed the immediate Force of the Exploſion, and ſecured the Houſe ; and the ſame Reaſons may obtain in larger and more extenſive

Phænomena. ‖ Sulphureous Exhalations, Electrical Effluvia, and other Cauſes might alſo contribute to convey the Agitation more ſenſibly to one Place than another, and hence the Percuſſion might move the Bells at *Croydon* without any Ways endangering the Buildings of *Weſtminſter*, or the City.

* The ſame Author mentions the burſting of a Spring in a Cellar; but the Fact itſelf appears very precarious and uncertain: we are told that ſome Water was diſcovered there ſoon after the Exploſion, and that next Day it was remarkably gone, and the Floor dry. We find no Account of any Alteration in the Floor itſelf, which might reaſonably have been expected, if a Spring had been raiſed by the Force of a ſubterraneous Convulſion. The Narration

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‖ See Dr. *Hales*'s *Conſiderations on Earthquakes.*

* See *Theory and Hiſtory of Earthquakes.*

fairly ſtated rather gives us Liberty to conclude, that the Water was introduced into the Cellar by ſome other Method than the Burſting of a Spring; but granting the Account, we have ſhewn that it is not inconſiſtent with the Power of an Aerial Shock.

Another || Writer, equally intitled to good Manners, and who perhaps was affected with the Diſappointment of the Third expected Shock, has endeavoured to aſſure the Public, that the late Exploſions near this Metropolis muſt be real Earthquakes; and is ſurprized that any People of common Underſtanding can think otherwiſe. In Order to prove his Aſſertion, he uſes the following decent Method.

1ſt. He ſays, that probably no Ball of Fire was ſeen in the laſt Concuſſion.

|| See the *London Gazateer*, *Friday April*, 13, 1750.

2d. That in both, the Sound was perceiv'd a conſiderable Time before the Shock.

3d. That in all Aeril Concuſſions, the Shock and the Sound are in reality the ſame Thing, and muſt be perceived at the ſame Inſtant.

4th. That the Shock was not moſt violent in the Weſt Parts.

In the firſt Propoſition he doubts of a Fact atteſted by || Authors in his own Way of thinking. One of them acquaints us, that a Ball of Fire; the other, that a vaſt Lightning was ſeen. It is therefore incumbent upon him to prove the Negative; 'till he has performed this arduous Task, I may juſtly retort upon him his own polite Expreſſions; that it is a groundleſs Ima-

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|| The Author of *Theory, &c.* of *Earthquakes*, and Dr. *Hales*.

Imagination, void of Truth, and ſuppoſed merely to ſavour a wrong Opinion.

That the Sound and the Shock were at a conſiderable Diſtance from each other, is likewiſe contradicted by the above Accounts; and I fancy by moſt that heard them. Dr. * *Hales* has computed, that the whole Duration of the laſt Exploſion from the Beginning to the End, was three or four Seconds of Time; no conſiderable interval therefore could paſs between the Noiſe and Concuſſion.

In the Third Propoſition, he obſerves, that in all Aerial Concuſſions, the Shock and the Sound are in reality the ſame Thing, and muſt be perceived at the ſame Inſtant; which is alſo fallacious.

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*See the above Accounts. The Author of the *Theory*, of *Earthquakes*, ſays, that in the firſt, the Noiſe and Shock were at the ſame Time.

The Sound and Shock in Aerial Exploſions, ariſe indeed from the ſame Cauſe, and are owing to Percuſſions of the Air. But however, they ſtand for different Effects, and excite different Ideas in the Mind. By the Sound is underſtood, that general Report cauſed by the Exploſion; by the Shock is meant, the ſhaking of Houſes, *&c.* Theſe Effects, tho' produced by the ſame Cauſe, communicate diſtinct Ideas to the Mind, and are not therefore any more the ſame Thing, than the Sound and Shock in ſubterraneous Exploſions.

Neither are they always or neceſſarily together. There are frequent Sounds and Percuſſions of the Air, without any attending Agitation of Houſes, *&c.* When indeed the Force is ſufficient to produce both, they more nearly accompany each other in Proportion to the Violence of the

Concuſſion. Hence in Aerial and ſubterraneous Exploſions, they are ſometimes almoſt inſtantaneous; but even in this Caſe, the Report prevents our immediate Attention to the Shock; and the Continuance of the Agitations make us imagine that the Sound conſiderably preceded them.

His laſt Objection is alſo the Denial of a Fact at the Time of the Exploſion generally ſuppoſed; and to diſprove which, he has only offered his bare Aſſertion. But upon a Suppoſition that the Shock was not more violent in the Weſt Parts of the City; it does not hence follow that it was an Earthquake; becauſe neither Aerial nor ſubterraneous Concuſſions are confined to one certain Direction.

In ſhort this Gentleman ſeems to be no better acquainted with the Circumſtances of the late Exploſions, nor the firſt Principles of Philoſophy than his Neighbours. He has given a bombaſt Deſcription of Concuſſions in the Air without any Manner of Diſtinction, and queſtioned Facts merely to ſupport the Notion of Earthquakes. And this, as he afterwards inſinuates, from the noble Deſign of continuing our Fears, and keeping us in Expectation of another moſt dreadful Shock. The World indeed is highly obliged to him for ſo ſingular a Spirit of Humanity and Benevolence.

Some whimſical Perſon has likewiſe objected to the Partiality of Exploſions in the Atmoſphere, but he may with equal Reaſon diſpute the Reality of local Thunder and Lightning, particular Earthquakes, or other limited Phænomena. It has been obſerved that a ſufficient Quantity of Exhalations, and a proper

Diſpoſition of the Air are required to produce theſe different Appearances; when and as often therefore as ſuch a Concurrence of Events happens in any Part of the Atmoſphere, we cannot but expect Aerial Exploſions proportionable to the Matter collected, *&c.*

The ſulphureous Smell, unuſual Warmth, and Calmneſs, preceding Airquakes partly reſult from the ſame Cauſes as in ſubterraneous Shocks. The Atmoſphere is repleniſhed with ſulphurous, and other Vapours, which, from the Preparation they undergo in the Element before they take Fire, produce the above Effects.

It is remarkable that the two Shocks near *London* happened at a certain periodical Diſtance from each other; this Occurrence has by ſome been imputed to a lunar Influence.

That the Moon has, according to its various Places, different Effects upon the Water, Atmoſphere, and other Things, Experience ſhews; 'tis not therefore impoſſible but it may concur in the Production of ſubterraneous and Aerial Exploſions. But that the particular Change of the Moon did not greatly influence the late Phænomena near this Capital, Appears from thoſe which intervened at other Places, and in different lunar Aſpects.

As to the Conſequences of Airquakes on Buildings, &c. they are proportioned to the Violence and Extent of them. Aerial Exploſions are ſeldom attended with any eminent Dangers or Devaſtation. Tempeſts and Hurricanes often threaten greater Deſtruction. In reſpect to their Influence on the Atmoſphere, they are generally ſo far from producing any ill Conſequences, that they prove vaſtly ſerviceable and benefical. That quantity of Sulphur which occaſions Airquakes, renders the Element ſultry, unfit for for Reſpiration, and almoſt ſuffocating; an Exploſion cools the Atmoſphere, deſtroys the noxious Vapours, and perhaps by this Means prevents ſome Epidemical Diſorders that might otherwiſe enſue. The Learned obſerve, that Diſtempers depend not a little on the Diſpoſition of the Air, and the ill Qualities contained in it. If ſo, ſuch an Alteration, as muſt accompany Aerial Concuſſions, might greatly tend to abate their Malignity: ſubterraneous Shock often fill the Atmoſphere with pernicious Damps, and unwholeſome Effluvia: hence it happens, that Sickneſs frequently follows them. On the Reverſe, Airquakes diſperſe and diſſipate theſe peſtilential * Vapours, and conſequently produce different Reſults.

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* It is not impoſſible, but the late Exploſions near this Capital, and in others Places, might in ſome Meaſure prevent the ſpreading of the Contagion among the Cattle, &c.

It has been obſerved that *England* does not abound with great Quantity of the *Pyrites* or *Iron-ſtone*, and other Materials proper for ſubterraneous Shocks. However, there is ſufficient to ſupply the Air with Exhalations, and produce various Meteors, and remarkable Concuſſions. If then we ſuppoſe the Atmoſphere at any Time replete with theſe Vapours, we cannot but expect uncommon Thunder and Lightning; or other Phænomena as Circumſtances in different Places ſhall conſpire to give them Vent. If we apply theſe Obſervations to the paſt Winter, we ſhall find them, correſpond with all Exactneſs. The unuſual Warmth and Dryneſs of the Seaſon repleniſhed the Atmoſphere with ſulphureous and other Steams: Hence aroſe the frequent Illuminations in the Sky. The Exhalations collecting together, ferment, and in ſome Places break in Thunder and

Lightning; as was remarkable in various Parts of *England*. In particular Places, where the Exhalations were more abundant; where a proper Mixture, and other Circumſtances occured, they collected into more denſe Bodies, exploded, and conſtituted Airquakes.

The Repetition of Aerial Concuſſions is very precarious; ſince the Production of them depends on many incidental Events. As an unuſual Warmth to extract the ſubterraneous Vapours; a proper Diſpoſition of the Air, and a particular Condenſation, Mixture, *&c.* to collect and enkindle them. Either therefore to foretel, enumerate, or expect them at determinate Periods, are idle illuſive Pretenſions. The Effects of a diſtermpered Brain or general Infatuation. The Change of Weather after the laſt Shock prevented all Fears of another near this

Metropolis; the remaining Exhalations being only ſufficient to explode in || Thunder. The Atmoſphere has ſince been more empty of ſulphureous Vapours and unſeaſonably Cold, which both contribute to illuſtrate that they were Aerial Concuſſions, and that we have no Reaſon at preſent to be apprehenſive of any more. In the Summer Months theſe Exhalations from the intenſer Heat and other Circumſtances are elevated higher in the Atmoſphere, are more ſubject to Effervescence and Accenſion, and therefore, uſually terminate in repeated and frequent Thunder and Lightning.

The Truth and Reaſonableneſs of this Account muſt be left to the Determination of the judicious Reader. Thus much however, I preſume, may be concluded from it; that to ſuppoſe the late Phænomena, to

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|| Towards the Middle of *April*, there were ſeveral Violent Thunder Storms near this Capital.

to have been Eploſions in the Air, is not ſo weak, abſurd, and unphiloſophical as the above ſubterraneous Gentlemen have endeavoured to repreſent, and that Perſons of Senſe and Underſtanding did not favour the Opinion without the Appearance of Reaſon.

It will perhaps be farther objected, that this Repreſentation of the late Phænomena tends to ſubvert the religious Conſequences drawn from them. To acknowledge a particular Province, and to take every Opportunity of recommending Virtue is undoubtedly the Province of a good Man. but we ſhould alſo guard againſt unreſonable Conſtructions, and unwarrantable inferences, leſt our Deſign to promote, might turn to the Diſgrace of Religion; leſt we not only lay ourſelves, but the invaluable Syſtem we profeſs, open to the keen Edge of Wit, and ridicule. All Events are under the Government of the Supreme Being, but to imagine hence, that the ſeveral Viciſſitudes which occur, are Deviations from the general eſtabliſhed Laws of Nature, or intended as particular Judgments and immediate Signs of the Conſummation of the World, will neither bear the Teſt of Scripture, Reaſon, nor Philoſophy. The Examples offered upon this Occaſion from the *Sacred Hiſtory* are not parallel. The Judgments from the Creation to the Call of *Abraham*, and from that Period to the *Jewiſh* Eſtabliſhment, were attended with Circumſtances plainly miraculous. The various Turns afterwards accompliſhed in their State, to the remarkable Deſtruction of *Jeruſalem*, had moſt evident Teſtimonies of a Divine Influence, and more immediate Interpoſition. We may therefore reaſonably expect, that the Notices preceding the laſt Conflagration, ſhall be accompanied with Marks ſufficient to convince us of the ſolemn Cataſtrophy they are deſtined to foreſhew. This indeed muſt neceſſarily be the Caſe; or how will theſe predicted Famines, Peſtilences, and Earthquakes be diſtinguiſhed from ſuch as happen in the ordinary Proceſs of Nature? or how will the Inhabitants of *Peru*, *Jamaica*, *Sicily*, and other Parts of the World, any Ways know ſuch important Earthquakes, from thoſe which their Country has been always liable to produce? Thus we may obſerve, that the Prophecies relating to the Subverſion of the Temple, were both literally and moſt wonderfully compleated. The ſubterraneous Convulſions, and various Phænomena in the Air, which defeated *Julian*'s Deſign of Rebuilding the * Temple (tho' accompliſhed by the Intervention of ſecond Cauſes) yet were attended with many extraordinary Circumſtances that manifeſtly declared the particular Direction of Almighty God. As the former Event was a faint Portraiture of the univerſal Deſtruction of the Globe, we may with the higheſt Reaſon ſuppoſe that the Signs portending ſo general a Fate to Mankind, will carry ſuch expreſſive Atteſtations of Divinity as none but the moſt hardned and abandoned ſhall preſume to queſtion. The late Phænomena were not accompanied with any unprecedented, preternatural, or pernicious Conſequences, that might illuſtrate them to be either national Inflictions, or Omens of an approaching Chaos; ſo far the contrary, that more violent Concuſſions have been felt in this Climate, and near this Metropolis; no unuſual baneful Influence followed them; they perhaps cooled and purified the Air, and prevented malignant orders in thoſe Places where the Atmoſphere was ſo abundantly furniſhed with inflammable and exploſive Vapours. The Misfortune is, we too often miſinterpret the Deſigns of propitious Heaven, and hence, we are apt to call thoſe Effects of Nature, Judgments, which in Reality are no leſs ſingular than unmerited Favours. The Degeneracy of our Manners and Contempt of Religion may indeed naturally induce us to apprehend the Worſe, ſince we cannot but be conſcious to ourſelves, how little we deſerve any Benefaction ſrom a Being, whoſe Commands we ſo often and flagrantly diſobey. Theſe Conſiderations might ſometimes tranſport us into a miſtaken and pardonable Zeal, when moderated with Meekneſs, and a juſt Regard for the Welfare of our Fellow-Creatures; but when we hence take occaſion to form a direful, deſtructive, and revengeful Character of the Deity, and are ready to call down Fire from Heaven to conſume Mankind; nothing can be more oppoſite to Reaſon, or the mild and benevolent Spirit of Chriſtianity. To ſeek the Protection of God in all Viciſſitudes is indeed no leſs our Intereſt than Duty; for whether they ariſe from his general or particular Laws, they are equally dependant on his Will and Direction. If they are Benefits, they are owing to his Munificence; if Calamities, he can at his Pleaſure avert them from us. In whatever Light we conſider the late Phænomena, we may without any abſurd Reflections, obſerve from them the ineſtimable Value of true Goodneſs; and the vain imaginary Horrors of Timidity and Guilt. How the one ſecures us againſt real or apparent Danger, how the other leads us into all the fatal Reſults of Terror and Diſtraction. Every uncommon Event preſents the Wicked with dreadful

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* See *Julian*, or a Diſcourſe concerning the *Earthquakes*, &c. which provoked the Emperor's Deſign to rebuild the Temple at *Jeruſalem*, by Mr. *Warburton*.

Apprehenſions ; whilſt the juſt and upright Man with Courage meets the moſt threatning Shocks of Fortune, or of Nature.

> *Si fractus illabatur Orbis,*
> *Impavidum ferient ruinæ.*
> Hor. L. iii. Od. iii.

In the noble Sentiments of the King of Wiſdom.

* *The Wicked flee, when no Man purſueth ; but the Righteous are bold as a Lyon.*

* Proverbs Chap. xxviii. Verſ. 1.

N. B. Whilſt this Account was in the Preſs, I have had an authentic Information, that the Shock attending the Exploſion, at the *Iſle of Wight*, laſt Summer, was ſenſibly felt above Twenty Miles.

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